

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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TABLE NO: _____

LECTURE SECTION TC01 / TC02 / TC03

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

**TCP2101 – ALGORITHM DESIGN AND ANALYSIS/
TCS3211 – ALGORITHM ANALYSIS**
(All Sections / Groups)

5 MARCH 2016
14.30 – 16.30
(2 Hours)

Question	Mark
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 12 pages with 5 Questions only.
2. Answer any **FOUR** out of FIVE questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers on **this Question paper**.

Question 1

a) An algorithm named **prefixUnknown** is provided below.

- i) Fill in the column named Number of Primitive Operations, and find the time complexity of the algorithm in big-O notation. [3 marks]

Algorithm prefixUnknown (A, n) Input: Array A of $n \geq 1$ integers Output: Array A with new values	Number of Primitive Operations in Big-O notation
for $i \leftarrow 0$ to $n-1$ do	
$A[i] \leftarrow 1$	
for $j \leftarrow 1$ to i do	
$A[i] \leftarrow A[i] * j$	
$T(n)$	

- ii) Use the prefixUnknown algorithm above, fill the value of $A[i]$ into the table below. [1 mark]

i	0	1	2	3	4	5
$A[i]$						

- iii) prefixUnknown algorithm performs a mathematical function. Name the mathematical function. [1 mark]

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- iv) It is possible to improve the above prefixUnknown algorithm by lowering the time complexity. Write an **improved** version of prefixUnknown **algorithm** and its improved **time complexity**. [2 marks]

Continued...

b) The following sequence of 4 integers is provided.

23 18 3 8

i) Find out the **hash value** for each element of the above sequence using the following hash function.

$$h(k) = k \% 5$$

Then create a hash table for the sequence. Use **linear probing** to resolve collision.

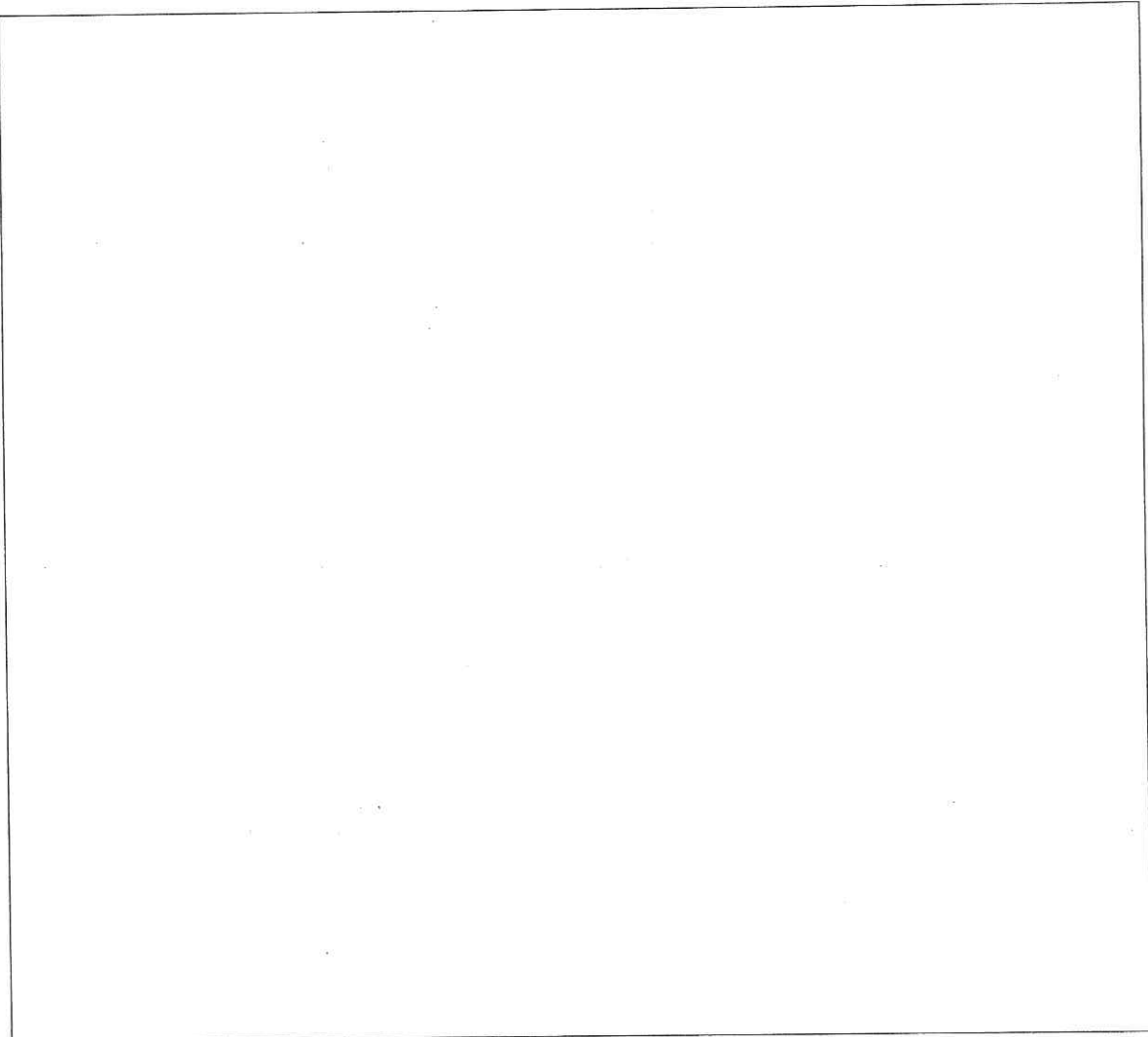
[2 marks]

ii) Is the hash function above a good hash function? Explain your answer. [1 mark]

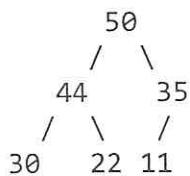
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Question 2

- a) Draw a simple **unbalanced** binary search tree (BST). State the overall **time complexity** for an unbalanced BST. **Explain** why an unbalanced BST has that time complexity. [2 marks]



- b) The following heap is provided.



- i) **Dequeue** the heap **four times**. Draw the **intermediate result** for the heap after each dequeue. [2 marks]

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1.	2.
3.	4.

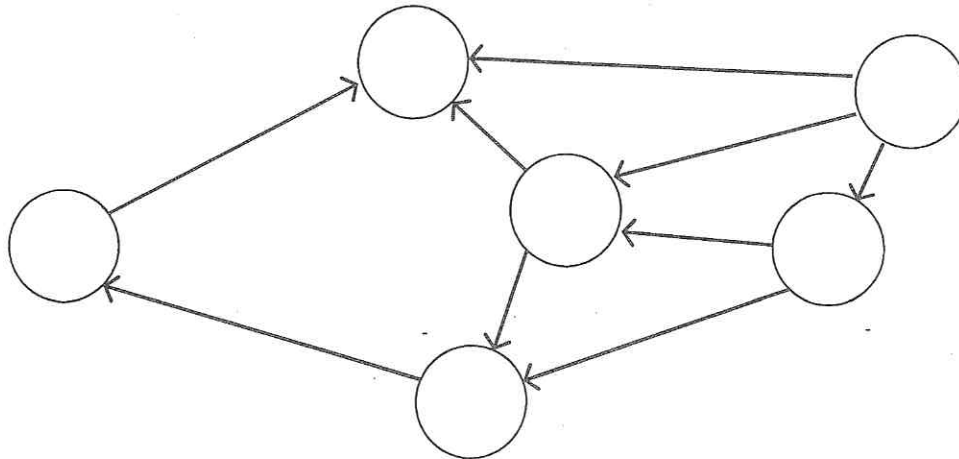
- ii) What is the difference between a Queue ADT and a Priority Queue ADT in term of dequeuing? [1 mark]

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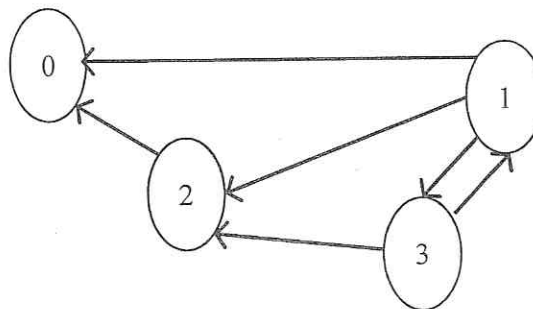
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c) The following graph is provided.

- i) Find the **Topological Sorting** for the following graph by labeling number 1-6 in the blank vertices provided. [3 marks]



- ii) A graph can be represented by an adjacency list. Draw an **adjacency list** for the following graph. [2 marks]



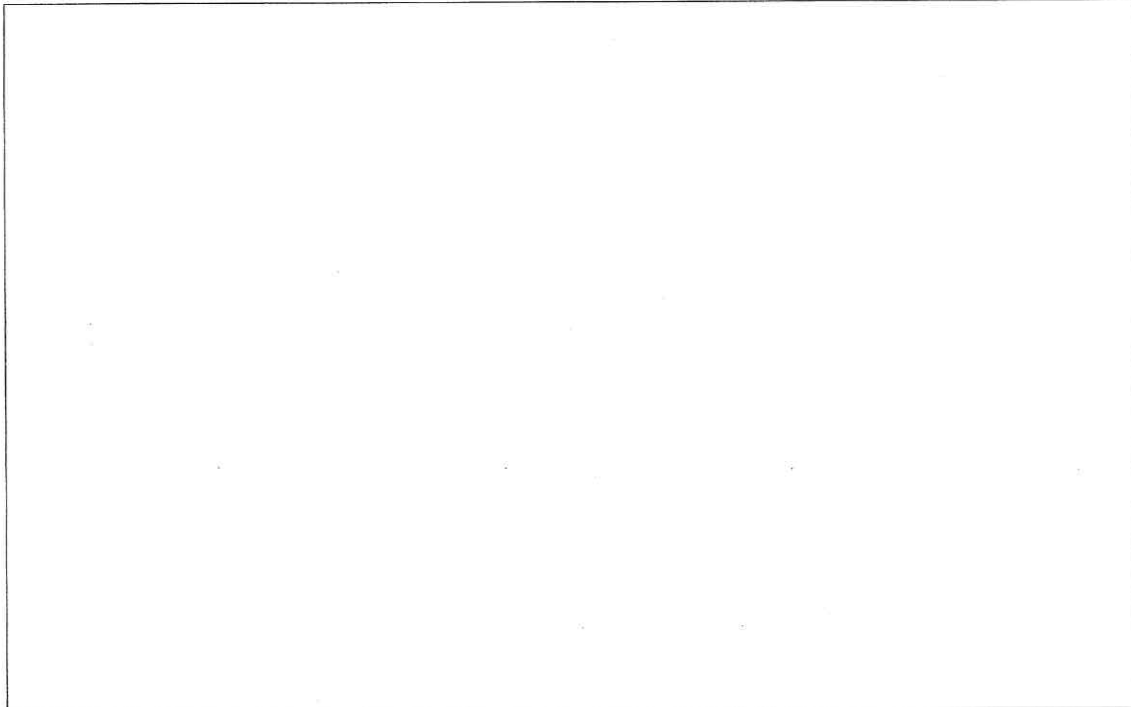
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Question 3

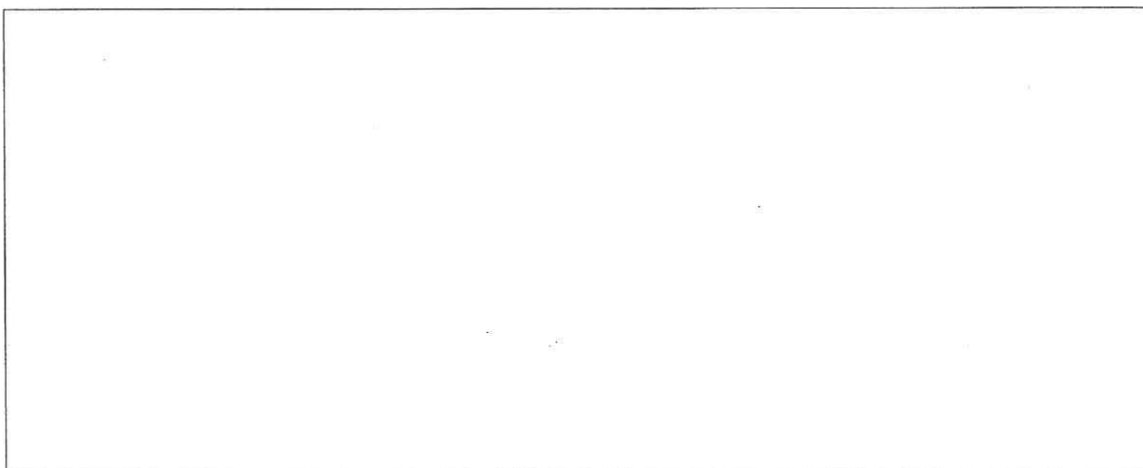
a) The following sequence of 8 integers is provided.

22 99 44 33 66 77 11 55

i) Sort the sequence using **Quick-sort** algorithm, Use the last element as pivot. Write down the **intermediate results**. [2 marks]



ii) What are the time complexities for Quick-sort in the **average case** and **worst case**? **When** will the worst case occur? **Suggest** a way to prevent worst case from happening. [2 marks]



Continued...

- b) The following sequence of 4 integers is provided.

33 44 99 22

Sort the sequence using **Selection-sort** algorithm. Write down the **intermediate result** and the **time complexity** of Selection-sort. [2 marks]

- c) Explain (step-by-step) how to use **quick-select** algorithm to find the 4th **smallest** element in the array $S = \{9, 11, 2, 6, 5, 4, 8, 12, 3\}$. For every partition in quick-select algorithm, the selected pivot is always the first element. State the **time complexity** for the quick-select algorithm. [4 marks]

Continued...

Question 4

- a) Explain the main difference of **Bucket-sort** as compared to **merge-sort** and **selection-sort**. Arrange the three sorting algorithms in **descending** speed (fastest $\rightarrow$ slowest).
[2 marks]

- b) Use **Master Theorem** to find the time complexity $T(n)$ for the following recurrence equations:

1. if $f(n)$ is $O(n^{\log_b a - \epsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a + \epsilon})$, then $T(n)$ is $\Theta(f(n))$,
provided $af(n/b) \leq \delta f(n)$ for some $\delta < 1$.

- i) $T(n) = 2T(n/2) + n^2 \log^2 n$
- ii) $T(n) = 9T(n/3) + n \log^3 n$

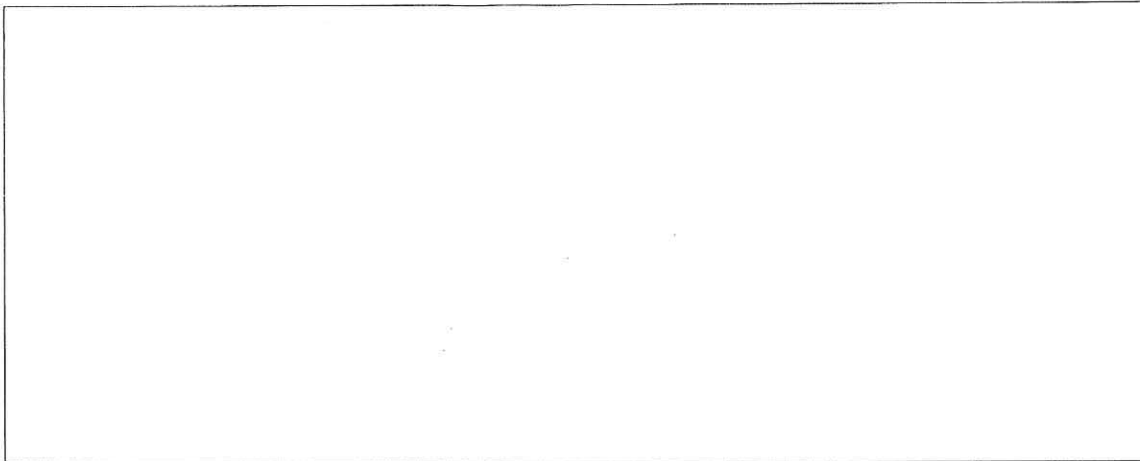
[3 marks]

- c) Use the **fractional knapsack algorithm** to select the following items with maximum total benefit but with weight (W) of at most 11kg. List the selected items and the maximum total benefit.

[3 marks]

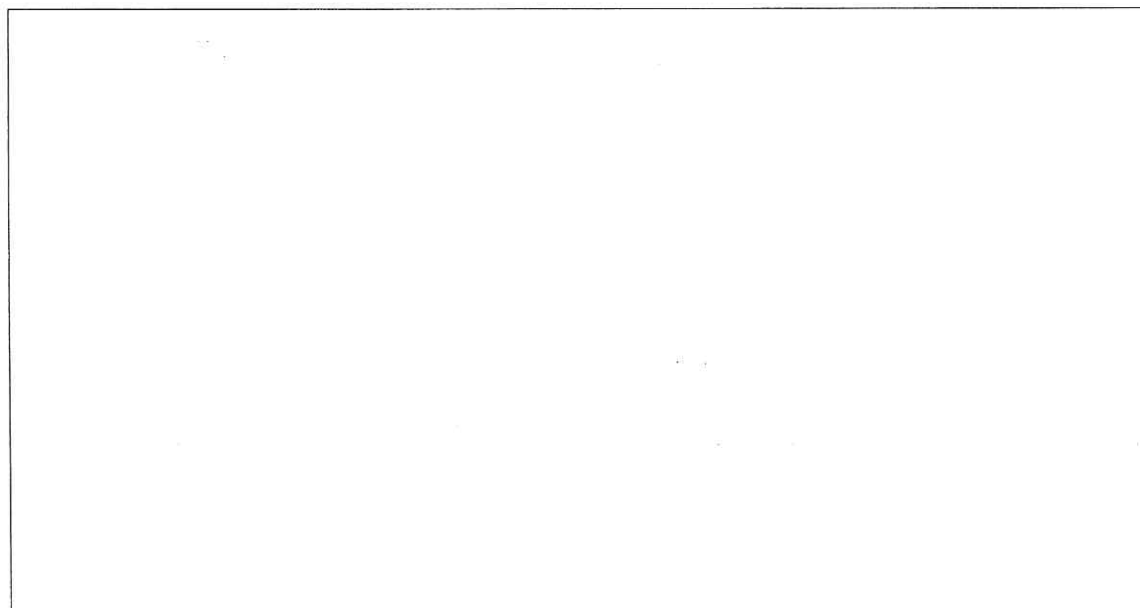
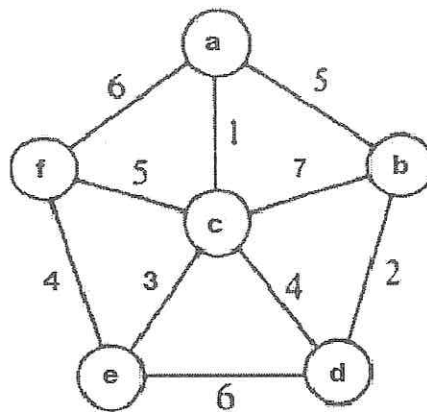
Item	P	Q	R	S	T
Weight (kg)	2	3	7	6	4
Benefit	5	12	21	27	28

Continued...



- d) Find the **minimum spanning tree** of the following graph using the **Kruskal algorithm**. Show the intermediate steps in your answer. State the **total weight** for this minimum spanning tree.

[2 marks]



Continued...

Question 5

- a) State the worst-case time complexities for the two text matching algorithms, i.e. **Brute-Force** and **Boyer-Moore**. In terms of speed, which one is significantly faster on English text? Explain your answer.

[2 marks]

- b) Complete the following pseudocode for the **bruteForce** algorithm. This algorithm is used to perform the exact matching between a pattern (P) and a text (T).

[3 marks]

```
Algorithm bruteForce( $T, P$ )
  Input text  $T$  of size  $n$  and pattern  $P$  of size  $m$ 
  Output starting index of a substring of  $T$  equal to  $P$  or -1 if no
  such substring exists

  for  $i \leftarrow 0$  to  $n - m$ 
    // your pseudocode starts here!

    // your pseudocode ends here!
```

- c) Use **dynamic programming** to solve the multiplication problem for the following matrix chain: M_1 : 18×12 , M_2 : 12×9 , M_3 : 9×6 , and M_4 : 6×30 . Fill up the following table with the optimal solution calculated from the multiplication of matrix chain.

[5 marks]

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	M_1	M_2	M_3	M_4
M_1				
M_2				
M_3				
M_4				

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